Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Amendment of the Commission's Rules to	)	WT Docket No. 04-435
Facilitate the Use of Cellular Telephones and	)	
other Wireless Devices Aboard Airborne Aircraft	)	
	)	

SPRINT COMMENTS

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Summary

Sprint makes the following points in its comments:

1. Sprint agrees with the FCC that "simply removing the cellular handset prohibition would not be in the public interest." The FCC adopted the cellphone prohibition in 1991 because of the interference that unconstrained use of airborne cellphones would cause to terrestrial networks. These same interference concerns apply regardless of the technology used in terrestrial networks and regardless of the specific band used by the CMRS licensee. Indeed, the need for interference protection is greater today given that wireless networks are currently used by over 182 million customers (versus the 7.5 million customers in 1991).

2. Sprint agrees that the theory of a pico cell architecture appears to be "promising," however, it is clear that major technical and operational issues must be addressed, tested and resolved before pico cell systems can be authorized. For example, all air interface technologies should be supported by the pico cell. Otherwise, handsets utilizing a technology not controlled by the pico cell could generate harmful interference to ground-based networks.

3. The 0 dBm power limit proposed for plane-based handset operations could cause harmful interference to terrestrial networks. Sprint performed a preliminary analysis of the interference risks that a single airborne handset operating at 0 dBm at the window of the aircraft would pose to its network. This analysis suggests that handsets operating that this level could cause significant and harmful interference to its terrestrial network. Mitigation techniques *may* be effective in eliminating such interference; however, in-depth studies and analyses of the overall interference problems and possible solutions must be completed and submitted for public scrutiny so that the Commission can make an informed decision on these matters.

4. The "communications pipe" and secondary use alternatives identified in the NPRM should not be pursued. Use of CMRS spectrum for the "communications pipe" would be more harmful than that posed by handsets in the cabin (not controlled by a pico cell). In addition, secondary use of the sort permitted in the cellular band with analog networks is not possible in the PCS band or with CDMA networks.

5. PCS licenses already possess the legal right to serve PCS handsets on airborne aircraft. Among other things, the FCC has already recognized that that PCS licenses include the right to provide services using network equipment located at 100,000 feet. Clearly, the FCC may not take away this right – that is, permit another firm to use Sprint's spectrum to provide to Sprint customers using handsets that are licensed to Sprint the personal communications services that Sprint provides.

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SPRINT COMMENTS

Sprint Corporation submits these comments in response to the Notice of Proposed Rule-making, which asks parties to discuss the steps the Commission can take "to facilitate the use of wireless handsets and devices, including those used for broadband applications, on airborne aircraft in appropriate circumstances."[1]

Sprint PCS is an industry leader in introducing new services and capabilities to the public. Sprint believes that the use of cellphones in airplanes that are in flight may well present a valuable new facet to existing CMRS services that has been largely untapped for various technical and regulatory reasons, and Sprint has begun examining the feasibility of providing this capability to the more than 25 million subscribers who use its network today. As a threshold matter, however, it is clear that widespread utilization of CMRS handsets on airplanes could cause significant interference to CMRS networks located on the ground.

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[1] *See Amendment of the Commission's Rules to Facilitate the Use of Cellular Telephones and Other Wireless Devices Aboard Airborne Aircraft*, WT Docket No. 04-435, *Notice of Proposed Rulemaking*, FCC 04-288, 20 FCC Rcd 3753, at ¶ 1 (Feb. 15, 2005), *summarized in* 70 Fed. Reg. 11916 (March 10, 2005)("*Aircraft NPRM*"). *See also Extension Order*, DA 05-1015, 70 Fed. Reg. 21724 (April 27, 2005). The focus of this *NPRM* is on airborne use of cellphones, because wireless carriers today provide services to their customers when they when located inside airplanes while on the ground.

In theory, pico cell concepts, coupled with mitigation techniques, such as limiting pico cell operations to certain altitudes, may potentially address interference concerns; however, there remain significant technical challenges that must be overcome before such operations can be authorized. In addition, Sprint believes that any potential solution must consider and balance the interests and concerns of the traveling public. CMRS licensees retain exclusive use rights over their spectrum, including its use by airborne handsets and pico cells, and thus have every incentive to work with manufacturers and others to develop technical solutions that will make the airborne use of cellphones feasible without causing unwanted interference to licensed networks on the ground.[2] Sprint looks forward to working with the rest of the industry toward achieving that goal.

While Sprint is cautiously optimistic that solutions to the inherent interference problems associated with the use of cellphones on airplanes in flight can eventually be developed, the fundamental rights of licensees to exploit their spectrum and operate their systems free from unwanted interference must guide the Commission's approach on this proceeding. Congress has declared that our nation's interest is promoted by the "operation of seamless, ubiquitous, and reliable wireless telecommunications systems."[3] The potential benefits of extending CMRS service to in-flight aircraft cannot be fully realized if such operations degrade the seamless, ubiquitous and reliable service upon which customers of existing wireless networks have come to rely. Accordingly, the Commission should not approve any regulatory construct for facilitating in-

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[2] Airborne cellphone use must also protect aircraft navigation and safety systems from interference. However, this is a subject under the domain of the Federal Aviation Administration ("FAA") and is already being addressed by relevant industry bodies (*see Aircraft NPRM* at ¶ 9), so Sprint will not address this matter in these comments.

[3] *See* Wireless Communications and Public Safety Act of 1999, PUB. L. NO. 106-81, at § 2(a)(6) (1999).

flight CMRS operations that would blanket ground-based CMRS networks with unwanted interference as a byproduct of such operations. The Commission should instead rely upon CMRS licensees working with other interested parties to resolve the numerous and complex technical issues.

In these comments, Sprint identifies some of the numerous issues that must be addressed before it could consider using its licensed spectrum for in-cabin service. Sprint's preliminary analysis suggests that a pico cell system, under the parameters discussed in the *NPRM*, could have significant and harmful impacts upon Sprint's terrestrial network and services. Accordingly, it is essential that technical studies and "real world" tests be conducted so these fundamental questions regarding the interference impacts of aircraft pico cell systems on terrestrial networks – as well as measures to prevent such impacts – can be addressed and resolved satisfactorily.

I. TERRESTRIAL NETWORKS CONTINUE TO NEED PROTECTION FROM UNCONTROLLED USE OF CELLPHONES ON AIRCRAFT IN FLIGHT

It is important to understand the origin of the current rule prohibiting use of cellphones on aircraft while airborne. The Commission adopted this rule prohibition 14 years ago because of the harm airborne use of cellphones (not constrained by any aircraft pico cell) would cause to terrestrial cellular networks:

> If a cellular telephone is used in an airborne aircraft, it will have a much greater transmitting range than a land-based cellular telephone and its signal will be received at a multiplicity of cell locations within the market, causing harmful operational interference. Furthermore, because a cellular telephone is capable of operating on all of the assigned cellular frequencies, serious interference could occur to cellular systems in other markets as well.[4]

[4] *See Airborne Use of Cellular Telephones*, 7 FCC Rcd 23 ¶ 5 (1991)(adopting Section 22.911(a) that was re-codified as Section 22.925 in 1994). Eighteen years earlier, the FCC prohibited use of land-mobile band devices for airborne communications when aircraft are flying above one mile, again to pro-

At the time this rule was adopted, wireless carriers used only the analog AMPS air interface and served 7.5 million customers (who used their phone an average of two hours a month).[5] Today, wireless carriers predominantly (or in Sprint's case, exclusively) use digital (2G or 3G) technologies, and they collectively serve over 182 million customers, each of whom averages over 500 minutes (or over eight hours) of use a month.[6]

It is important for the Commission to understand that the terrestrial network interference concerns that lead it to adopt the prohibition for analog cellular networks apply equally well to digital networks.[7] In addition, uncontrolled airborne cellphone-generated interference will cause harm to terrestrial services regardless of the specific spectrum band used by a CMRS licensee – whether the 800 MHz cellular band, the 1.9 GHz PCS band, the 800/900 MHz SMR band or other bands that have been allocated to CMRS, including the 1.7/2.1 GHz Advanced Wireless Services ("AWS") and 700 MHz bands.

In fact, airborne cellphone use presents an even more serious problem for CDMA networks than for AMPS or TDMA (including GSM) networks. CDMA is the most efficient wireless air interface available today.[8] In part this is because CDMA technology is designed to be

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tect terrestrial land-mobile networks from interference. *See Use of Land Mobile Frequencies Aboard Aircraft*, 42 F.C.C.2d 505 ¶ 2(1973); 47 C.F.R. § 90.423.

5 *See* CTIA Semi-Annual Wireless Industry Survey (Dec. 2004).

6 *See id.*

7 Digital networks require appropriate signal-to-noise ratios for acceptable operation, and when additional interference interrupts this ratio, the quality of service degrades. Hence, the problem that airborne cellphone use causes is fundamentally the same for both analog and digital technologies. Although some believe (incorrectly) that digital signals are inherently more resistant to interference than analog signals, in fact, with "multiple voice conversations digitally 'stacked' onto the same channels as before, the digital signals are *less* robust than analog technology with respect to external interference." V-Comm Comments, ET Docket No. 03-237, at 36 (April 5, 2004)(emphasis in original).

8 Among other things, CDMA is designed to use the least amount of power necessary to maintain "toll quality" service; indeed, system power is controlled nearly 1,000 times a second to determine whether a handset can use less power (or requires more power). This power control is important both to

capable of using all frequencies in every cell site/sector (N=1), while AMPS and TDMA networks ordinarily use the same frequency in only one of every seven cells (N=7). Thus, interference generated from an airborne cellphone would impact all CDMA cells in line-of-sight of the airplane, whereas interference from the same airborne cellphone may cause interference to only one of every seven AMPS and TDMA cells in line-of-sight of the airplane.[9]

There are two additional facts the Commission needs to understand about airborne use of cellphones not controlled by an onboard pico cell. First, airborne cellphone emissions will transmit at far greater distances than handset emissions when located on the ground (because ground signals are "attenuated" by terrain, buildings, *etc.*). For example, signals received from an airborne cellphone at 100 miles from a terrestrial base station (assuming line-of-sight) will generally be 100 to 10,000 times stronger than signals received from a ground-based handset 100 miles away. The point is that airborne cellphones can cause considerable harmful interference at considerable distances.

Second, thousands of base stations (or cell sites) can be in view and in line-of-sight of a single airplane, as reflected by the following table:[10]

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customers (as handset battery lives are extended) and to carriers (as unneeded power to serve one customer can be used to serve other customers in the cell). In addition, CDMA networks are designed to operate very close to the thermal noise floor, and customer traffic can (and does) operate below the noise floor. As a result, CDMA networks are particularly sensitive to increases in the noise floor, and any such increase has a direct and negative impact on coverage, capacity and service quality.

[9] This example assumes that the TDMA carrier is not using frequency hopping. If such hopping is used, TDMA carriers may be able to use additional frequencies at each site, but then the impacts of interference from airborne cellphone use would become more significant. It is Sprint's limited understanding that GSM is able to use spectrum more efficiently than TDMA networks, *e.g.*, N=4.

[10] For purposes of this table, Sprint has assumed a base station radius of three miles and assumed that 50 percent of the base stations in range of the aircraft will be in view of handsets inside airplane cabins.

Aircraft Altitude (feet)	Line-of-Sight Distance (miles)	# of Ground Sites in View
5,000	87	417
10,000	122	833
20,000	173	1,667
30,000	212	2,500
40,000	245	3,333

In summary, Sprint agrees fully with the Commission that "[s]imply removing the cellular handset prohibition . . . would not be in the public interest."[11]

II. MANY ISSUES NEED TO BE ADDRESSED, TESTED AND RESOLVED BEFORE A PICO CELL SYSTEM CAN BE SUCCESSFULLY DEPLOYED

The Commission seeks comment on the use of wireless handsets controlled by on on-board pico cells. Such a pico cell would, in effect, operate as "a low power cellular base station installed in the aircraft for the purpose of communicating with (and controlling the operations of) cellular handsets or other cellular devices brought on the aircraft by passengers and crew."[12] The theory is that "interference to terrestrial cellular stations would be prevented because the airborne pico cell would minimize handset power levels by instructing handsets to operate at their lowest power setting."[13]

Sprint agrees with the Commission that a pico cell architecture is "promising" because it has the potential, at least in *theory*, to support airborne wireless services without harming terrestrial services and networks.[14] But the Commission needs to understand that there are numerous – and major – practical and technical issues that need to be addressed, tested and resolved before

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11 *Aircraft NPRM* at ¶ 12.

12 *Id.* at ¶ 13.

13 *Id.* at ¶ 14.

14 *See id.* at ¶ 13.

such an architecture can be successfully utilized in the provision of service, and Sprint below discusses some of these outstanding issues. As noted at the outset of these comments, Sprint's primary objective is to ensure that current services, including coverage and reliable service quality, are not negatively impacted by a pico-cell system of in-flight PCS services.

A. A pico cell needs to be all-inclusive by including all CMRS air interfaces and all CMRS spectrum bands. Airborne cellphone use poses a substantial risk of harmful interference to terrestrial networks, as discussed in Part I above. The Commission correctly recognizes:

> [W]ithout a ready pico cell on the aircraft, airborne handsets would normally operate at their highest power setting in an attempt to reach base stations located far away on the ground, potentially causing interference to terrestrial cellular networks.[15]

But it is important for the Commission to understand that *the identical interference problem will occur even with an operational onboard pico cell if the pico cell cannot communicate with a handset because it is not designed to use the handset's assigned spectrum band or the handset's particular air interface*.

Sprint is aware that firms are developing pico cell systems for CDMA and GSM. However, Sprint is not aware of development work with regard to other air interfaces, such as iDEN, UMTS or TDMA. The fact is that customers generally do not know (or care) about such details as the air interface and spectrum bands that their handsets utilize. Thus, if a passenger with an iDEN phone, for example, sees a passenger in the next seat using his Sprint PCS handset, the passenger will understandably assume that she can use her service as well. But if the onboard pico cell does not support the iDEN interface (and the spectrum bands used by the service), the pico cell cannot control the handset. And, if the pico cell cannot control the handset, *the handset*

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15 *Aircraft NPRM* at ¶ 14.

will attempt to communicate at full power with the carrier's terrestrial network and thereby generate interference into the network.

In addition, it appears that there is no practical way to restrict the use of non-pico cell-supported handsets because neither passengers nor flight attendants will be able to distinguish non-supported phones from supported phones.[16] Accordingly, *if any phones are supported by a pico cell, then all phones – both spectrum bands and air interfaces – must be supported*.[17] Among other things, for a pico cell to control all handsets on an airplane, it must:

- Be capable of operating on all CMRS spectrum bands, including cellular, PCS, SMR, AWS, 700 MHz and other bands that may be allocated to CMRS in the future;
- Be capable of supporting all wireless technologies including CDMA, GSM, TDMA, AMPS, iDEN, 3G/UMTS, SMS, GPRS, EDGE, CDPD and Bluetooth; and
- Be capable of supporting all wireless services because different services may be provided using different technologies or frequencies (*e.g.*, channels dedicated for EV-DO used for data traffic only).

As becomes immediately apparent, having an "all inclusive" pico cell will necessarily increase the size, complexity and cost of a pico cell.[18]

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[16] In theory, it might be possible in the future for handset vendors to develop an "airplane friendly mode" which might include a visual indication that the handset is being controlled by the pico cell, is not communicating with a terrestrial network, and is transmitting only at the authorized output power level. However, Sprint does not know whether such a feature could be developed and, if so, at what cost (*e.g.*, the cost to include this feature in all handsets would outweigh the additional revenues from providing airborne PCS service). Even if such indicator could be incorporated into future handset models, it seems impractical and unreasonable to expect other passengers and crew members to affirmatively monitor the cellphone use of others in flight.

[17] The *NPRM* asks whether the pico cell concept should be extended to the PCS and EMSR bands. *See Aircraft NPRM* at ¶¶ 20-21. In fact, as discussed in the text, a pico cell system must necessarily include all bands if terrestrial networks are to be protected.

[18] It would be impractical, and likely cost-prohibitive, for each licensee to install its own pico cell on aircraft. Sprint therefore assumes at this early stage that licensees would cooperatively work together so all handsets can be supported by only one or two pico cells.

B. Addressing the handset "look for home network first" design issue. Handsets are designed so that when they are powered on, they look for their "home system," not an aircraft pico system. Thus, even if an aircraft pico cell is operational, a handset will initially search for its own terrestrial network and, if necessary, operate at full power in an attempt to communicate with one of its network's base stations.[19] This would cause the very interference to terrestrial networks discussed in Part I above (and if operating at full power, could cause the handset to generate interference inside the aircraft, including to the plane's safety and navigation systems).[20] It is thus essential that pico cells operate under the control of licensees to avoid this problem and that licensees develop a means to prevent this interference from occurring.[21]

C. The handset preferred roaming list issue. Even assuming the handset "look for home network first" design issue can be overcome, industry still needs to address the subject of preferred roaming lists ("PRLs") in connection with aircraft pico cells. Most handsets are designed to include PRLs, so customers roam only on those networks with which their underlying provider has a roaming agreement and to prefer one roaming network over another. It will be critically important that handsets include the correct PRLs of all aircraft pico cells so they are capable of communicating with each other (and this is particularly the case if licensees need to assign separate SID/NIDs to the pico cell). If the PRLs are not coordinated, the handset again will attempt to communicate at full power with its home terrestrial network, generating the very uncon-

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[19] Moreover, a handset will generally search first for its home network even when the received signal level from the onboard pico cell is stronger than the terrestrial signals received in the cabin.

[20] As noted, RTCA is currently studying the impact of CMRS handsets on aircraft safety and navigation systems, but this study is not scheduled for completion until the end of 2006.

[21] It might be possible, for example, for licensees to assign unique SID/NIDs to distinguish the pico cell systems from terrestrial networks. Sprint looks forward to reviewing the suggestions that pico cell developers are examining to address this problem.

trolled interference discussed in Part I above. Sprint suspects that the wireless industry would need to develop standards to manage this PRL issue.

D. International Mobile Phones. Whether phones used in other countries will work with a pico system will, of course, depend on the design of the pico system. To the extent these international phones do not use spectrum allocated to CMRS in the United States, these phones should not pose an interference risk to our nation's CMRS networks. However, these phones may cause interference to non-CMRS U.S. radio networks that use the same spectrum that the handset is designed to use, including government and public safety radio systems. This potential interference risk to other (non-CMRS) U.S. radio networks needs to be fully understood.

E. "Real word" testing of interference risks. Over 182 million Americans rely on wireless service in their daily lives.[22] CMRS is important to public safety,[23] and is also important to our nation's economy.[24] Vendors of both customer handsets and network equipment have ad-

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[22] *See* CTIA Semi-Annual Wireless Industry Survey (Dec. 2004).

[23] For example, CTIA estimates that wireless customers made 72.5 million 911 calls in 2003 – or nearly 200,000 calls each day. *See* www.ctia.org/research_statistics/statistics/index.cfm/AID/216. *See also* THE WALL STREET JOURNAL, *Cellphone Hangup: When You Dial 911, Can Help Find You*? (May 12, 2005)("[M]ore than a third of the 190 million calls placed to 911 each year now come from cellphones."). Airborne interference that either prevents a land phone from accessing a wireless network or that causes E911 location data to be less reliable would undermine the Congressional policy that the "operation of seamless, ubiquitous, and reliable wireless telecommunications systems promote public safety." Wireless Communications and Public Safety Act of 1999, PUB. L. NO. 106-81, at § 2(a)(6) (1999).

[24] For instance, economists advised the FCC last year that "the capitalized value of the consumer benefits in the wireless phone market alone (ignoring producers' surplus and multiplier effects) is approximately $900 billion." *See* Comments of Thomas Hazlett and Matthew Sptizer, ET Docket No. 03-237, at 33 (April 5, 2004). Similarly, a study released earlier this year determined that use of mobile data services increased average workforce productivity by 13.4 percent per week – the equivalent of adding five more hours per worker per week – and that in 2003, use of mobile data services by U.S. workers contributed 1.9 percent to the Gross Domestic Product of approximately $10.4 trillion. *See* Omni Consulting Group Press Release, "Study finds 13.4 Percent Increase in Worker Productivity from Use of Mobile Data Services" (Feb. 9, 2005), *available at* www.omniconsultinggroup.com/aboutus/press/feb0905press.php.

vised the Commission that even small amounts of new external interference can cause substantial harm to terrestrial CMRS networks.[25]

Clearly, the Commission needs to ensure that airborne cellphone use does not jeopardize the reliability, coverage or capacity of current terrestrial CMRS networks. The only way the Commission can conclude with certainty that airborne cellphone use will not pose an interference risk to terrestrial networks is to defer any decision until comprehensive and conclusive "real world" tests are conducted and thoroughly analyzed.

F. The Cumulative Effects of Interference. The Commission has recognized that what is important in an interference analysis is not the power levels of a transmitter, but "the cumulative effects of all undesired RF energy . . . that is present at a receiver at any instant of time."[26] Thus, establishing an emissions limit for a single airplane is of no value if 100 airplanes are simultaneously in view of a terrestrial base station, each of which may be generating energy onto the base station's receiver. Understanding the effects of cumulative interference generated from multiple airplanes will be critically important in developing emission levels that protect terrestrial networks from harmful interference.

G. Cellphone use "ground rules" and education. It is inevitable that "ground rules" concerning the use of cellphones on airborne aircraft will be required, and these rules must be developed. Thereafter, an extensive campaign must then be undertaken to educate both wireless cus-

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[25] *See, e.g.*, Ericsson Comments, ET Docket No. 03-237, at 13 (April 5, 2004); Lucent Comments, ET Docket No. 03-237 (April 5, 2004); Motorola Comments, ET Docket No. 02-135, at 13 (Jan. 27, 2003); Nokia Comments, ET Docket No. 02-135, at 4 (Jan. 27, 2003); Qualcomm Comments, ET Docket No. 03-237, at 7-12 (April 5, 2004). Independent experts have reached the same results. *See, e.g.*, Dr. Jay E. Padgett and Dr. Robert A. Ziegler, Telcordia Technologies, Inc., *Analysis of Interference Temperature Concept to Support Sharing Between Licensed Services and Unlicensed Devices* (April 2004), *appended as* Attachment A to Sprint Comments, ET Docket No. 03-237 (April 5, 2004); V-Comm Comments, ET Docket No. 03-237 (April 5, 2004).

[26] *See Interference Temperature NOI/NPRM*, 18 FCC Rcd 25309 ¶ 1 (2003).

tomers/passengers and flight attendants concerning these rules. CMRS licensees are best situated to educate their customers on the use of cellphones on airborne aircraft, which is one more reason why the use of cellphones on airborne aircraft should be coordinated and controlled by the CMRS licensees themselves.

* * *

The discussion above makes apparent that there are numerous – and major – technical and operational issues that must be addressed before any licensee can decide whether the benefits of a pico cell system outweigh the costs. The procedures under which the Commission must operate – legal pleadings and *ex parte* meetings with only a handful of interested parties in attendance – are not suitable for a comprehensive resolution of all the issues. Sprint therefore recommends that the Commission refer these operational and technical issues to the industry for further study and the preparation of a report if it believes that the pico cell theory has merit.

III. PICO CELL SYSTEMS CAN ALSO CAUSE HARMFUL INTERFERENCE TO TERRESTRIAL NETWORKS

The Commission asks whether it should adopt technical rules, including emission limits, regarding the onboard operation of pico cells.[27] Such rules will no doubt be essential. At this early stage, however, it is not clear that pico cell systems can be deployed without causing harmful interference to advanced CDMA networks. It may be feasible to deploy various mitigation techniques to prevent such interference. Such measures may, for example, limiting pico cell operations to altitudes above the 10,000-foot level. Considerable technical analysis and tests, however, are still necessary before technical rules and other required measures to eliminate unwanted

[27] *See Aircraft NPRM* at ¶ 16.

interference can be established, and Sprint looks forward to reviewing the analyses that pico cell system developers presumably will be submitting with their comments.

The principal interference concern associated with the operation of pico cell systems is the signal power of handset transmissions, not a pico cell's transmissions to the handsets.[28] In particular, because airborne cellphones may have a direct line-of-sight to multiple base stations on the ground, the only attenuation of a handset's emissions is free space loss and whatever attenuation is provided by the aircraft itself. Handsets operating at aircraft windows likely will experience no attenuation whatsoever, other than free space loss.

The *NPRM* suggests that the interference risk posed by airborne cellphone use would be minimized (if not eliminated altogether) by a pico cell system, because the pico cell would "instruct[] handsets to operate at their lowest power setting."[29] It seems theoretically possible for pico cells to power-range CDMA handsets, assuming that the pico cell licensee identification information has been programmed into the handset's Preferred Roaming List (although additional study is required to confirm this assumption). As the Commission notes, CDMA handsets are designed to operate at very, very low power levels (-50 dBm), which would reduce the potential for interference to base stations on the ground.[30] However, the 0 dBm power limit proposed by the Commission – which appears to the lowest power setting of a PCS GSM handset and which constitutes 100,000 times more power than the lowest designed level of a CDMA handset – appears to be too high to protect terrestrial networks from interference.

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[28] Although onboard pico cell-to-handset transmissions represent a potential for interference to the operation of handsets at ground level, Sprint assumes that the pico cell would be located sufficiently within the framework of the aircraft such that the signal power of its transmissions will be attenuated below that which would interfere with handsets operating on the ground.

[29] *Aircraft NPRM* at ¶ 14.

[30] *See id.* at ¶ 4.

Sprint has begun to analyze the interference risks that airborne handsets would pose to its CDMA network if the handsets were permitted to operate 0 dBm. (Sprint's analysis did not consider any possible mitigation techniques, which are beyond its direct knowledge as a service provider). The following table shows that even a single airborne cellphone operating at 0 dBm in the window of an airplane can significantly increase the noise floor in the PCS band:[31]

Altitude (feet)	**Rise In The PCS Band Noise Floor (based upon the worst-case angle of arrival)**		
	One Airplane	**Two Airplanes**	**Four Airplanes**
10,000	2.530 dB (angle of arrival: 30°)	4.119 dB (angle of arrival: 30°)	6.194 dB (angle of arrival: 30°)
20,000	0.385 dB (angle of arrival: 25.34°)	0.738 dB (angle of arrival: 25.34°)	1.369 dB (angle of arrival: 25.34°)
30,000	0.354 dB (angle of arrival: 35.38°)	0.682 dB (angle of arrival: 35.38°)	1.270 dB (angle of arrival: 35.38°)

TABLE 2: INTERFERENCE GENERATED BY AIRPLANES HAVING A SINGLE HANDSET OPERATING AT 0 DBM

Although Sprint suspects that it may be feasible to deploy various measures to eliminate the emissions of airborne handsets, the baseline potential for interference is nonetheless discon-

[31] For this study, the interference to the PCS network from the aircraft was computed using the rise in the noise floor at the base station for the antenna gain at the angle of arrival under examination (the angle of arrival was computed based upon the aircraft being located at 3.28, 8, 16, 32, 64, 128 and 256 ground miles from the PCS base station). Because this approach limited the number of elevation angles examined, the table does not necessarily show the worst case. The 0 dBm handset was assumed to be located at an aircraft window, such that the only losses were due to free space loss. The propagation model used line-of-sight represented by 36.6 + 20 Log (d) + 20 Log (f), where d is the length of the hypotenuse in miles formed by a right triangle whose base is the distance from the PCS network in ground miles, whose height is the elevation of the aircraft in feet, and where f is equal to 1850 MHz (PCS A Block subscriber-to-base station transmissions). The study utilized actual manufacturer antenna tabular data for a base station antenna model that Sprint currently uses in its network.

certing. As the analysis shows, even a *single handset* operating in the window of an airplane could cause increases to the noise floor approaching and, in fact, exceeding 1 dB – and this potential for interference increases as more airplanes come into line-of-sight with the base station, which seems likely to occur in the airspace that surrounds airports. Such increases to the noise floor would have harmful consequences not just to Sprint's CDMA network – and on the over 25 million people that use this network in their daily lives – but to all co-channel networks on the ground, regardless of the air interface technology they utilize.[32] For example, the developer of the CDMA technology that Sprint utilizes recently advised the Commission that CDMA networks would suffer "a significant loss of capacity and CDMA wireless phones will suffer a significant loss of battery life" even if external interference is increased at "a relatively modest level such as 1 dB."[33] According to Qualcomm, even with an increase in the noise floor of 1 dB:

- A CDMA network operator would face "a 10-15% decrease in the coverage area of [its] CDMA cell sites;"
- This service provider would have to "add 12-17% more cell sites to maintain its present coverage in the face of a 1 dB increase in noise temperature;"
- With a 1 dB increase in the operating noise floor, "CDMA mobile phones would suffer a 20% decrease in battery life;"
- PSAPs would receive reduced location position yield and positioning accuracy because "[e]very one dB increase in the GPS enabled mobile terminal's effective interference temperature translates to a one dB decrease in sensitivity."[34]

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[32] A noise floor study earlier submitted to the FCC demonstrates that the PCS band today exhibits "low noise floor conditions," with the result that CDMA networks can "utilize the lower noise floor conditions occurring in these market areas with the system's processing gain, which is able to utilize signals below the thermal noise floor of its receivers" and "can fully utilize the spectrum and offer maximum coverage and capacity." *See* V-Comm, *PCS Noise Floor Study*, ET Docket No. 02-135, at 2, 35-36 (Sept. 16, 2003). Similarly, an FCC study of the nearby GPS band found "very low levels of ambient radio noise in outdoor environments." *See* Public Notice, *FCC Staff Releases Report*, ET Docket No. 98-153, DA 02-2786, at 2 (Oct. 22, 2002).

[33] Qualcomm Comments, ET Docket No. 04-163, at 9 (June 3, 2004).

[34] Qualcomm Comments, ET Docket No. 03-237, at 7, 8, 11 and 12 (April 5, 2004).

Manufacturers of CDMA network equipment and customer handsets,[35] as well as independent experts,[36] have made the same point to the Commission – namely, the introduction of even small amounts of new external interference would harm CMRS networks and the quality of services provided to customers.

Economic studies submitted in the record quantify the adverse effects of a rise in the noise floor. A national carrier like Sprint would have to spend billions of dollars in building additional cell sites to offset the loss of capacity and coverage from a 1 dB increase in the noise floor.[37] Of course, it would take a carrier like Sprint years to find and obtain approval of thousands of additional cell site locations (and it is unrealistic to think, given the difficulties in the zoning and siting processes, that carriers will be able to obtain additional sites in all of the locations needed). In the end, it would be customers who would suffer in the form of degraded quality of service (*e.g.*, more dead zones, higher rates of dropped calls) and higher prices due to the additional network investment – simply in an effort to return the network to its current level of service. It is for these reasons that Sprint is concerned by any increase in the noise floor.

As indicated, Sprint suspects that these damaging impacts to CDMA networks might be reduced through the use of several mitigating measures, and Sprint looks forward to analyzing specific measures that pico cell system developers may be considering. But as a service provider whose network is used by over 25 million people, Sprint – and the Commission – will need de-

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[35] *See, e.g.*, Ericsson Comments, ET Docket No. 03-237, at 13 (April 5, 2004); Lucent Comments, ET Docket No. 03-237 (April 5, 2004); Motorola Comments, ET Docket No. 02-135, at 13 (Jan. 27, 2003); Nokia Comments, ET Docket No. 02-135, at 4 (Jan. 27, 2003).

[36] *See, e.g.*, Dr. Jay E. Padgett and Dr. Robert A. Ziegler, Telcordia Technologies, Inc., *Analysis of Interference Temperature Concept to Support Sharing Between Licensed Services and Unlicensed Devices* (April 2004), *appended as* Attachment A to Sprint Comments, ET Docket No. 03-237 (April 5, 2004); V-Comm Comments, ET Docket No. 03-237 (April 5, 2004).

[37] *See* Comments of Thomas Hazlett and Matthew Spitzer, ET Docket No. 03-237, at 41 Table 5 (April 5, 2004).

tailed – and documented – proof that the steps proposed to protect Sprint's network from interference generated by developers' equipment will, in fact, work.

IV. THE "COMMUNICATIONS PIPE" AND SECONDARY USE ALTERNATIVES SHOULD NOT BE PURSUED AT THIS TIME

The Commission additionally seeks comment on two alternatives to a pico cell architecture: use of cellular spectrum as an air-to-ground "communications pipe," and additional air-to-ground service through use of secondary use licensing. The "communications pipe" alternative would appear to present a far greater risk of harmful interference to terrestrial networks than do airborne handsets, as discussed in Part I above.[38] This is because an antenna mounted on the belly of an aircraft would be able to see all base stations below it – unlike handsets inside the cabin, which may be blocked from view of certain base stations because of the cabin/shell of the aircraft.[39] If there are advances in technology that would make such a "communications pipe" application feasible (and further assuming that other available "communications pipe" spectrum becomes congested), then, as the Commission recognizes, the CMRS industry would have the "strong incentive" to develop the concept without regulatory intervention.[40]

The *NPRM* further seeks comment on allowing "any cellular licensee to provide cellular service to airborne units on a secondary basis," although the NPRM does not define this concept

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[38] However, CMRS spectrum could be used for a "communications pipe" if a firm holds licenses for nationwide spectrum in one block and chooses to use that block for air-to-ground communications rather than for terrestrial services.

[39] Sprint also cannot agree with the FCC's tentative conclusion that transmissions from an aircraft antenna at 0 dBm (1 milliwatt) power is "sure to prevent harmful interference to terrestrial base stations." *Aircraft NPRM* at ¶ 24. However, it is difficult for Sprint to response to this statement because the *NPRM* did not identify the specific test data or analysis upon which it is based.

[40] *See id.* at ¶ 23.

in any way.[41] The Commission needs to understand that secondary use of the sort permitted in the cellular band with analog networks is not possible in the PCS band – or with CDMA networks.

The Commission justified secondary use in the cellular band because of the way the cellular rules define a licensee's protected service area – that is, "by use of a mathematical formula" rather than by "the physical locations where subscriber units can receive service."[42] As a result, the Commission determined that a cellular licensee in one area could serve airborne customers over another area where it did not hold a license. This "overlap service" arrangement is not possible in the PCS band because a PCS licensee's protected service area is based on geography, such as a BTA or MTA, without regard to any mathematical formula.[43] As discussed in Part V below, PCS licensees hold exclusive rights to use their PCS spectrum. This necessarily means that no one else can use a licensee's spectrum – including a PCS licensee in an adjacent market.

Secondary use in bands used by CDMA technology is also not feasible in the vast majority of cases. As discussed above, equipment vendors and independent experts have repeatedly advised the Commission that any increase in the noise floor harms CDMA network operators by reducing their capacity or coverage.[44] Thus, any secondary use of CDMA spectrum necessarily

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41 *Aircraft NPRM* at ¶ 24. *See also id.* at ¶ 25 (We "seek[] to optimize the secondary use contemplated under this proposal.").

42 *See AirCell Order*, 15 FCC Rcd 9622, 9635 n.93 (2000); 47 C.F.R. § 22.911(a). In addition, the FCC applied this formula to two analog network, not digital networks.

43 *See* 47 C.F.R. § 24.202. Consequently, because of this difference between the cellular and PCS rules, the court's decision in *AT&T Wireless* v. *FCC*, 270 F.3d 959 (D.C. Cir. 2001), is not relevant to PCS licensees.

44 *See* nn. 25, 35 and 36, *supra.*

will cause harmful interference to a CDMA network operator if the secondary use increases the noise floor.[45]

V. PCS LICENSEES POSSESS THE LEGAL RIGHT TO SERVE PCS HANDSETS ON AIRBORNE AIRCRAFT

The Commission proposes that CMRS "licensees should have the right to operate pico cell systems on their licensed frequencies."[46] However, it then asks whether third parties, "besides or in addition to" licensees, should be given rights to airborne use of licensed spectrum "under a separate authorization."[47] Sprint demonstrates below that its PCS licenses include the right to serve PCS mobile stations on aircraft that use its licensed spectrum. The Commission may not take away this right – that is, permit another firm to use Sprint's spectrum to provide to Sprint customers using handsets that are licensed to Sprint the very kind of personal communications services that Sprint provides – at least without exposing the federal government to substantial damages liability.

Sprint's PCS licenses authorize it to provide personal communications services within the geographic areas specified in the licenses (*e.g.*, BTAs, MTAs).[48] Personal communications services are defined broadly to include "any mobile communications service on the[] assigned spec-

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[45] In addition, secondary use is feasible only if there is a way for the primary licensee to identify harmful interference generated by the secondary use and stop the interference. But as the FCC has previously recognized, it is not practical for licensees to identify the source of interference when the secondary user is mobile, as in the case with moving airplanes. *See Radar Detector Order*, 17 FCC Rcd 14063, 14067 ¶ 11 (2001). "Further, these interference sources are not under the control of the [primary licensee], so in most cases it is not possible for the [primary licensee] to remedy the interference even if the source could be identified." *Id.*

[46] *Aircraft NPRM* at ¶ 17. Of course, licensees would need the permission of the premises owners – in this case, the airlines.

[47] *Id* at ¶ 18.

[48] *See* 47 C.F.R. § 24.202.

trum," as well as "[f]ixed services . . . provided on a co-primary basis with mobile operations."[49] The Commission has recognized that a "grant of a PCS license confers on the licensee an exclusive right to use the designated portion of the electromagnetic spectrum for the term of the license."[50] The Commission has further recognized that it "must protect [PCS licensees'] exclusive right to the spectrum and refrain from authorizing others to use that spectrum."[51]

PCS licenses include the right to provide services to PCS mobiles onboard aircraft. After all, if an airborne handset can communicate with a PCS terrestrial base station (or generate interference into the terrestrial network), the licenses necessarily must include the right to provide these services (or protect itself from interference). In this regard, the Commission has already recognized that PCS licenses encompass the right to provide services using network equipment located at 100,000 feet.[52]

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[49] 24 C.F.R. § 24.3.

[50] *Public Utility Commission of Texas*, 13 FCC Rcd 3460, 3503 ¶ 89 (1997). *See also PCS Reconsideration Order*, 9 FCC Rcd 7805, 7807 ¶ 10 (1994)("[W]e did not adopt an open architecture spectrum plan [for PCS] but instead adopted a plan with only one license per spectrum block per service area."); *UWB Reconsideration Order,* 18 FCC Rcd 3857, 3886 ¶ 74 (2003)("[C]ellular and PCS licenses are exclusive in the sense that no other carriers will be allowed to provide cellular or PCS service in the same frequency band, in the same area, and at the same time."); *Implementation of Section 309(j),* 10 FCC Rcd 7970, 7995 ¶ 42 (1994)("[A] licensee has exclusive use of a block of contiguous channels, such as in cellular and PCS."); *BellSouth* v. *FCC,* 162 F.3d 1215, 1223 (D.C. Cir. 1999)("CMRS spectrum is a finite resource and is also exclusive in that whatever one entity holds cannot be held by another.").

[51] FCC Brief, *FCC* v. *NextWave Personal Communications*, Nos. 01-653 and 01-657, at 46 n.10 (May 6, 2002). The exclusive rights held by PCS licensees may be broader than the exclusive rights held by cellular licensees. In its *AirCell Order*, 15 FCC Rcd 9622, 9635 n.93 (2000), the FCC held that a cellular licensee's protected service area boundary is determined "only by use of a mathematical formula in § 22.911(a)," and not by "the physical locations where subscriber units can receive service." In contrast, a PCS licensee's protected service area is based on geography, such as a BTA or MTA, without regard to any mathematical formula. *See* 47 C.F.R. § 24.202.

[52] *See Space Data Order*, 16 FCC Rcd 18431 (2001). *See also AirCell Order*, 14 FCC Rcd 806 (1998)(AirCell is permitted to provide its air-to-ground service because it resells cellular spectrum from cellular licensees, and the licensees remain "solely responsible" for AirCell's operations, including ensuring that AirCell does not interfere with other cellular licensees).

Sprint acknowledges that Section 316 of the Communications Act extends to the Commission the legal authority to modify licenses.[53] To exercise this authority, however, the Commission must demonstrate that the proposed modification "*will* promote the public interest, convenience, and necessity."[54] Sprint submits that a Commission decision precluding Sprint from serving its own customers and permitting other firms to use Sprint frequencies in the provision to Sprint customers of the same kinds of services that Sprint provides cannot be said to promote the public interest.[55]

Importantly, a Commission decision that the public interest is promoted by reducing Sprint's rights to serve its own customers will not end the matter. The Commission and the courts have repeatedly held that an auction of PCS licenses establishes a contract between the federal government and the licensee, under which both parties owe duties to each other.[56] PCS carriers paid the U.S. Treasury sizable consideration for their license – in Sprint's case, billions of dollars – and they invested additional billions in relocating incumbent licensees in the PCS band and in constructing operational networks.

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53 *See* 47 U.S.C. § 316. Courts have recognized that the Section 316 procedures must be utilized when the FCC issues a new license that may potentially cause interference to an existing licensee. *See, e.g., Wilson* v. FCC, 170 F.3d 793 (D.C. Cir. 1948).

54 *Id.* at §§ 316(a)(1)(emphasis added). Congress further made clear that the burden of demonstrating that a license modification "will promote" the public interest "shall be upon the Commission." *Id.* at § 316(b).

55 Among other things, the very integrity of the auction process would be destroyed if the FCC begins reducing licensee rights after the fact. In this regard, the FCC has stated that one of its foremost objectives is to "maintain the integrity for all of our future auctions and to ensure that all participates are treated fairly and impartially. These elements are essential if the financial community is to have the stability it requires to fund the new communications enterprises and services for which this spectrum should be used." *Second PCS Payment Plan Order,* 12 FCC Rcd 16435, 16437 ¶ 3 (1997). *See also PCS Installment Payment Reconsideration Order,* 13 FCC Rcd 8343, 8348 ¶ 7 (1998).

56 *See* Sprint Reply Comments, WT Docket No. 03-202, at 17 n.63 (Jan. 26, 2004)(case citations).

A Commission decision holding that other firms may begin using Sprint spectrum to provide personal communications services to Sprint customers would constitute a material breach of the auction contract and upset Sprint's justifiable reliance on the set of rights that it acquired with its licenses. Under these circumstances, the Commission would be subject to the same contractual remedies (*e.g.*, money damages) that would be applicable if a substantial breach occurred in a contract between private parties.[57] A reduction in a licensee rights would also constitute a taking under the Fifth Amendment of the U.S. Constitution, which is unlawful unless the affected licensee receives just compensation.[58]

In summary, the Commission should reaffirm that licensees possess the right to operate pico cell systems on their licensed frequencies (subject to permission by each airline). Sprint submits that there is no need at this time for the Commission to become involved in the complex issue of "how these rights should be apportioned or shared among such licensees,"[59] because Sprint is confident that the wireless industry can cooperatively work out these details.[60] It does bear noting that the industry's ability to develop a fair and equitable solution for all licensees will be aided substantially by the flexible secondary market rules that the Commission recently adopted.[61]

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[57] *See, e.g.*, *Mobile Oil* v. *U.S.*, 530 U.S. 604, 608 (2000)("When the United States enters into contract relations, its rights ad duties therein are governed generally by the law applicable to contracts between private individuals.").

[58] *See, e.g.*, *Loretto* v. *Teleprompter Manhattan CATV Corp*., 450 U.S. 419 (1982); *Penn Central* v. *New York City*, 438 U.S. 104 (1978).

[59] *Aircraft NPRM* at ¶ 17.

[60] It is, moreover, likely that these business details cannot be addressed in any detail under the interference issues have been examined more fully.

[61] *See First Secondary Markets Order*, 18 FCC Rcd 20604 (2003); *Second Secondary Markets Order*, 19 FCC Rcd 17503 (2004).

VI. CONCLUSION

Sprint is excited about the possibility of providing a new in-flight capability to its customers. At the same time, Sprint cannot realistically consider offering this capability if it would degrade the quality of services received by customers today.

For the foregoing reasons, Sprint respectfully requests that the Commission take actions consistent with the views expressed above.

Respectfully submitted,

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